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THESIS

**GERMANY'S ENERGY DEMAND AND SUPPLY UNTIL
2020: IMPLICATIONS ON GERMANY'S FOREIGN
ENERGY POLICY**

by

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June 2003

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IMPLICATIONS ON GERMANY'S FOREIGN ENERGY POLICY**

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The purpose of this thesis is to provide an overview of Germany's energy supply options until 2020, the political implications and the respective consequences for Germany's foreign energy policy. The oil and gas supply situation for Germany will become more complex in the upcoming decade. Since oil imports from the UK and Syria are expected to cease after 2005, 18% of the current oil supply will have to be substituted within this decade. Russia may not be available to provide the amount necessary. The gas situation is somewhat less urgent, as a supply shift will have to take place only after 2010, when the Norwegian and Dutch gas reserves cease to satisfy the export demand. The only regions that will be able to provide oil and gas on a global level to meet the growing world demand will be the Middle East, Russia and other Caspian Sea neighbors. Germany's welfare is directly dependent on its economical success. As a highly industrialized country, Germany should take a tremendous interest not only in the future development of the international energy market, but also in attempting to influence the development immediately following that of its domestic needs.

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I. INTRODUCTION

The purpose of this thesis is to provide an overview of Germany's energy supply options until 2020, the political implications and the consequences for Germany's foreign energy policy.

Germany is one of the world's largest and strongest economies. However, it lacks significant domestic energy sources and is heavily reliant on imports. Roughly two-thirds of Germany's total energy consumption in 2001 was based on imported energy sources. The US governmental Energy Information Agency (EIA) has classified these different types of energy sources, which provided for the total energy consumption, as follows: Oil (41%), Natural Gas (23%), Coal (23%) and Nuclear Power (11%). 94% of the consumed oil and more than 75% of the gas are imported. Even in the case of coal, which Germany produces in large quantities, the country is a net importer. The vast majority of energy consumption forecasts for Germany until 2030 are expecting a light increase of around 1% per year. However, the German government has decided to phase out nuclear energy production, which will be achieved approximately by 2021 - 2023. In addition, rising gas consumption and the ecological and economical constraints on coal, e.g. the Kyoto Protocol, will inevitably lead to a further increase in Germany's import dependence. Parallel to this development is the overall world consumption forecasted with nearly 60% increase by 2025, which implies a sharp increase of the competition on the demand side, as some of the currently existing regional oil and gas reserves become already depleted soon after the turn of this decade. As Germany has currently no distinctive energy strategy and the European Union (EU) only recently started to discuss a common strategy, it is decisive to point out the implied constraints on the regional energy supply options.

This thesis views only the non-domestic energy development without examining domestic political mechanisms in depth. Additionally, the focus lies on oil and gas as this will be the future energy sources after nuclear energy is phased out; and coal is constrained by environmental and competitive disadvantages. Renewable energy sources are expected to account only for less than 10% in 2010 and little more than 10% in 2020

of the then total energy consumption. The perspective of this thesis will be limited until 2030 as nearly all precise forecasts and predictions are either until 2020 or 2030. Hence, any need and definition of an energy strategy will be limited to this timeframe.

This thesis explains why the supplier composition will change soon after 2010, when the reserves of Germany's current suppliers become increasingly depleted. Therefore, the country has to re-orientate on the global energy market to find adequate substitution.

Consecutively, the development on the supply side of the world market until the middle of the upcoming decade is examined.

In the concluding chapter, the thesis draws out some implications for German energy policy. The chapter argues that Germany's welfare is directly dependent on its economical success. As a highly industrialized country, Germany should take a tremendous interest not only in the future development of the international energy market, but also in attempting to influence the development immediately following that of its domestic needs.

II. GERMANY'S ENERGY DEMAND

A. PRESENT ENERGY SITUATION

This chapter lays out the basis for a general understanding of Germany's energy needs, starting with the description of current consumption and origins of the imports. The subsequent section provides an explanation of the political constraints on the German energy sector, particularly the firm commitment to phase out nuclear energy production. The final section of this chapter deals with the future energy demand in Germany.

The data provided in this chapter are extracted from official German government publications, the International Energy Agency (IEA), and the Energy Information Administration (EIA) of the U.S. Department of Energy (DoE). Most of the newest accumulated data are from 2001; the 2002 data are extracted from press releases published by the Federal Office of Economics and Export (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*, or BAFA), which have been very accurate for the last few years. The forecasts and predictions by the DoE/EIA, however, are from May 2003.

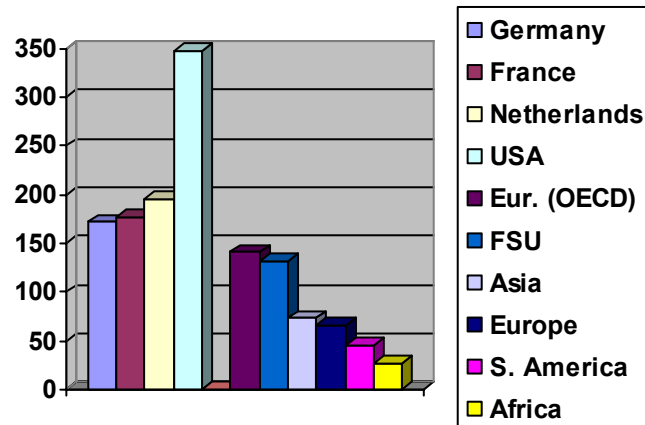
1. Domestic Consumption

Germany is the one of the world's largest energy consumers, for per capita, as well as for total consumption. In 2001, Germany consumed 172 gigajoule (GJ). Only the Netherlands, France and USA had a higher appetite for energy.¹ (See Figure 2.1). Germany's economy is persistently the world third-largest economy after the United States (US) and Japan. In 2001, the gross domestic product (GDP) was \$2,274 billion, only the US with \$9,394 billion and Japan \$4,376 billion had a stronger economy.²

¹ Bundesministerium f. Wirtschaft u. Technologie (BMWi), *ENERGIE DATEN 2002: Nationale und Internationale Entwicklung* (Berlin/Köln: BMWI, 2002), 39.

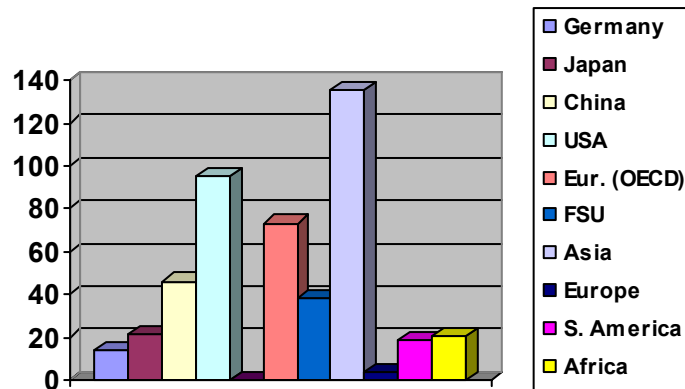
² DoE/EIA, *International Energy Outlook* (Washington: National Energy Information Center, 2003), 8.

Figure 2.1: GJ / Capita (2001)



This high economy based per capita consumption rate makes Germany, in combination with a population of over 82 million, the world's fourth-largest energy consumer after Japan, China and the USA. Figure 2.2 illustrates the total consumption in 2001, providing a comparison to the regions and countries noted in figure 2.1.³

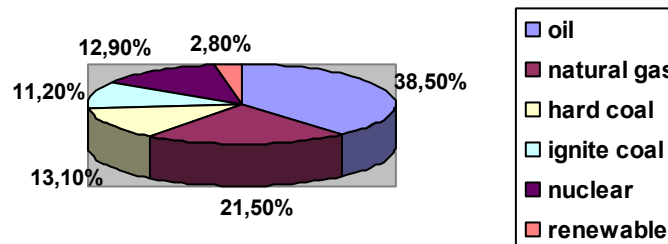
Figure 2.2: Total Energy Consumption in exajoule (EJ)



³ Ibid.

The consumption (approximately 85%) is primarily covered by fossil-fuel energy carriers (Figure 2.3).⁴

Figure 2.3: Primary Energy Consumption (2001)



However, with the exception of coal, Germany's own energy resources are rather insignificant. Germany is the third-largest oil consumer in the world, Europe's largest coal consumer and the second-largest natural gas consumer. The country constitutes by far the largest energy market in Europe.

While Germany consumed 2.7 million barrels/day (bbl/d) of oil in 2002, only 69,000 bbl/d of crude oil were produced domestically. As result, over 97% of the required oil had to be imported.⁵ The production-consumption-ratio on the natural gas market is partly more positive. In 2001, Germany produced 0.78 trillion cubic feet (Tcf) of natural gas and consumed 3.3 Tcf, indicating that over 76% of the consumed natural gas was imported.⁶ Although Germany, by far, is Europe's largest producer of hard and lignite coal it has had to import hard coal since 1990. In 2001, coal was responsible for 24.3% of Germany's primary energy consumption, hard coal 13.1% and lignite coal 11.2%. However, in that domestic hard coal is not competitive on the international market, because of the geological conditions and high labour costs, 54% of the consumed

⁴ BMWI, 10.

⁵ DoE/EIA, *Germany Country Analysis Brief* (March 2003), <http://www.eia.doe.gov/emeu/cabs/germany.pdf> (09 June 2003).

hard coal and 1% of lignite coal are imported. This also makes Germany a net coal importer.⁷

In summary, 60% of Germany's energy consumption in the last few years had to be imported. The origins of the energy imports are described in the next section.

2. Imports and Origins

This section begins with oil imports and its origins, because oil accounts for the largest share of Germany's energy consumption and Germany largely relies on oil imports. Second in the sequence is gas, followed by hard coal.

As stated earlier, Germany is over 97% dependent on oil imports. What is remarkable is the diversification of the origins (Figure 2.4). The importance of Russia and Norway has steadily increased over the last twelve years primarily due to the significant decrease of oil imports from the Middle East and the Organization of Petroleum Exporting Countries (OPEC). In 2002, OPEC accounted for a mere 19.5% only.⁸ The Russian share, meanwhile, increased from little over 24% in 1991 to 31% in 2002. Moreover, the Norwegian portion rose from 7.5% to 21% in the same period.⁹ In the decade from 1991 to 2001, this increased the import of crude oil by 19.2%, while also slightly increasing its part in the primary energy consumption from 35% to 38.5%.¹⁰

⁶ Ibid.

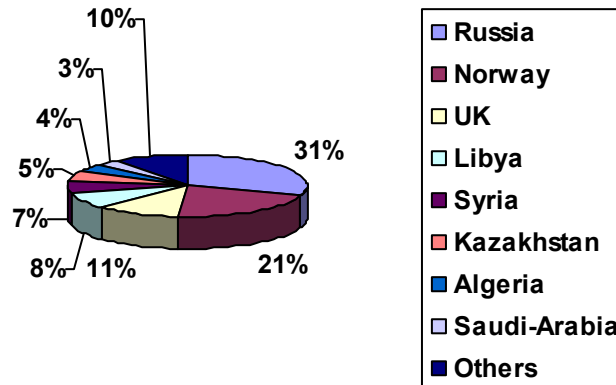
⁷ Federal Ministry of Economics and Labour, *Reserves, Resources and Availability of Energy Resources 2002* (Berlin: FMEL, 2002), 5.

⁸ BAFA, *EnergieINFO R12-2002* (10 February 2003), <http://www.bafa.de/1/de/service/statistik/statistik.htm> (09 June 2003).

⁹ BMWI, 19.

¹⁰ BMWI, 10, 19.

Figure 2.4: Crude Oil Imports (2002)



(After: BAFA, *EnergieINFO R12-2002* (10 February 2003),
<http://www.bafa.de/1/de/service/statistik/statistik.htm> (09 June 2003); (BMWI),
ENERGIE DATEN 2002: Nationale und Internationale Entwicklung
 (Berlin/Köln: BMWI, 2002), 10, 19.)

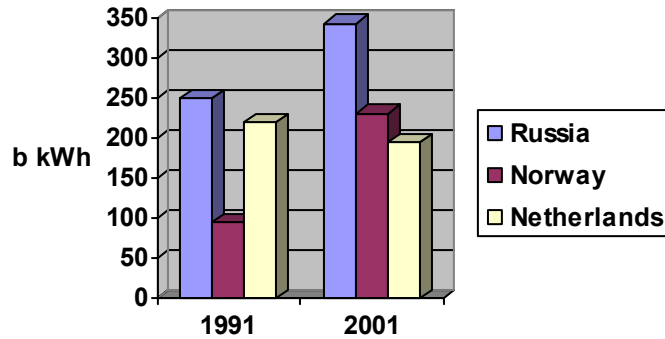
The international gas providers are not diversified to the same extent as that of the oil sources. Over 94.5% of Germany's natural gas imports are provided by three countries. Russia accounts for 45%, Norway for 27% and the Netherlands for 22% of the gas imports in 2000.¹¹ In general, the reliance on natural gas for the energy supply increased from 15.5% in 1990 to 21.5% in 2001.¹² Although all three states together had the same share of Germany's gas imports at the beginning of the 1990s, there was a shift away from the Netherlands towards Norway, while Germany increased its reliance on Russian gas (Figure 2.5).¹³

¹¹ DoE/EIA, *Germany Country Analysis Brief*.

¹² BMWI, 10.

¹³ Ibid., 23.

Figure 2.5: Gas Imports 1991 vs. 2001



Coal is the only fuel that actually lost its former significance as an energy provider, although lignite coal is the only sufficient domestic energy resource. Still in 1990, hard and lignite coal accounted for 37% of the energy consumption. In 2001, its share, combined and divided, had fallen to little more than 24%.¹⁴ This trend seems to have continued as the import of hard coal in 2002 decreased further, by nearly 12% compared to 2001.¹⁵

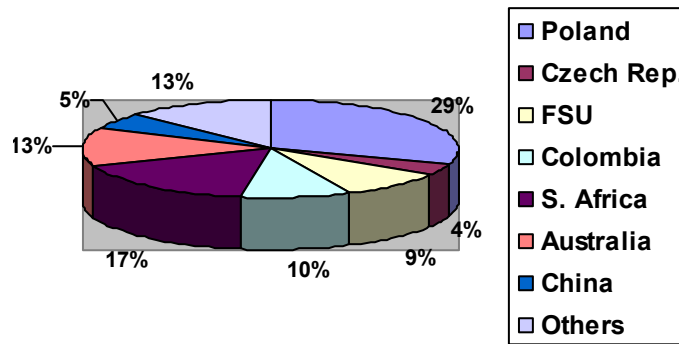
On the other hand, unlike any other energy resource, the import of hard coal is globally diversified. Germany's main supply (87%) comes from seven nations across all continents (Figure 2.6).¹⁶

¹⁴ Ibid., 10.

¹⁵ BAFA.

¹⁶ BMWI, 25.

Figure 2.6: Hard Coal Imports (2001)



But how is the energy consumption itself structured and for what reason is the energy used? This question will be answered in the next section.

3. Consumer Structure

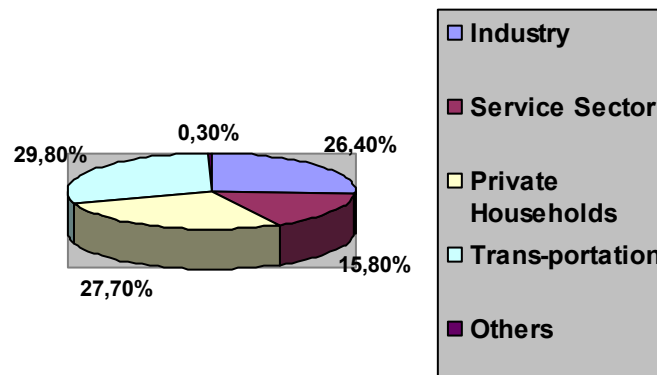
Since 1990, the trend in energy consumption is moving away from the industrial sector towards the transportation sector and private households (see figure 2.4).¹⁷ Several reasons are responsible for this change. For the most part, there has been a shift from the heavy industry to an increasing, less energy intensive, service sector and the restructuring of the East German economy. On the other hand, more and more goods are transported along land and road access. The “just-in-time delivery” provides one explanation, but the superior flexibility of road transportation and the ever-increasing importance of Germany as a European transit corridor, particularly for the east-west transit, is another. Moreover, there is also the increasing number of private households and private mobility, contributing to a constant growth in the number of vehicles.¹⁸ The

¹⁷ Ibid., 11-13.

¹⁸ IEA, *Energy Policies of IEA Countries: Germany 2002 Review* (Paris: OECD/IEA, 2002), 45.

number of private households, for example, increased approximately 10% during the period of 1990 to 2000.¹⁹

Figure 2.7: Structure of Germany's Energy Consumption (2000)



The energy markets and use of energy are traditionally one of the most regulated and politically influenced sectors of the economy. These influences on the German energy situation are highlighted in the following section.

4. Policy Constraints

The political influences and constraints on Germany's energy situation can be viewed on three levels: the national, European Union (EU) and international level. This section explains the most important policy constraints and influences from the top-international level down to the national level.

The most influential international constraint is the Kyoto Protocol, which Germany ratified in April 2002. By ratifying this agreement, Germany committed itself to reduce its greenhouse gas (GHG) emissions to 8% by 2010 compared to 1990. However, within the EU-Burden-Sharing-Agreement addressing the Kyoto Protocol,

¹⁹ BMWI, 5.

Germany agreed to reduce its GHG emissions by a total of 21%. Subsequently, Germany decided voluntarily to increase this figure to 25% already in 2005.²⁰

A second constraint, albeit more indirectly, is the WTO membership. As the aim of the WTO is to create a non-discriminatory, most liberal (world) market, this has also stimulated an influence on the energy market, particularly with respect of lowering tariffs with the aim to create a liberal energy market.

Increasingly, the EU is influencing the German energy market. The common EU electricity-and-gas market is of direct importance. The aim of the regulations is to gradually achieve an EU-wide liberalized market for electricity and gas. The more the EU has legislative power over its member states, the greater the prospect is that Brussels will regulate the energy sector. Furthermore, the fair-trading, anti-trust and subsidy laws / agreements on EU level are successively overriding national regulations.²¹

National policy, however, is currently still the most direct influential factor. In order to achieve the ambitious goal of a 25% reduction of GHG emissions till 2005, the German government is heavily promoting (and subsidising) renewable energies on the one hand, and on the other hand, taxing the use of fossil fuels with the so-called *eco-tax*. Additionally, the government implemented energy efficiency programs, particularly for the private household sector, with an emphasis on conservation measures.²²

The most drastic political action, however, was the decision by the ruling Social Democratic-green coalition to abandon nuclear energy production. This aim was the motivation and spirit of the Green Party, whose roots are nuclear disarmament movement at the early of the 1980s.

The government started the negotiations on the regulations of the nuclear-phase-out within the industry immediately following their election in 1998. Finally, an agreement between the government and the industry was signed in June 2001 and the relevant law, the Atomic Energy Act (*Atomgesetz*),²³ was changed in April 2002 by the parliament. In accordance with the agreement, the total production of the nuclear power

²⁰ Mineralölwirtschaftsverband (MWV), *MineralölForum: Energiemarkt im Wandel* (Hamburg: Druckerei Saphir Druck + Verlag, 2001), 32-33.

²¹ BMWI, *Nachhaltige Energiepolitik für eine zukunftsfähige Energieversorgung: Energiebericht* (Berlin: Möller Druck, 2001), 12.

²² IEA, 38-39.

plants is limited to 2,623 terawatt-hour (TWh). However, it is transferable among the plants. This results in an average lifetime of 32 years per nuclear power plant, so that the last plant will terminate its production, approximately over the period of 2020 to 2023.²⁴ Although the opposition parties, both Christian Democrats (CDU) and Liberals (FDP), intend to retain nuclear energy production, the public is divided.²⁵ The public is deeply divided on the issue of nuclear energy expenditure / usage, which is also reflected in the on-going surveys conducted by the EU.²⁶ It is not probable that a change in the government would lead to a substantially different policy, as the anti-atom movement could count on support of a respectable part of the society.

The problem is, nevertheless, that nuclear power plants are providing 30% of the German electricity in 2001, which results in roughly 13% of the total primary energy supply in Germany.²⁷ The German government expects nuclear energy to be substituted primarily by gas and renewables, but also by conservation measures and efficiency improvement. In one scenario (see next section), even coal is perceived to serve as a viable substitute for nuclear energy.²⁸

It is obvious that the policies of GHG and CO₂ emission reduction and the phasing out of nuclear energy production, on the other hand, are at least partly at loggerheads. The future will indicate how the policy will react to this contradiction, whether with more or less political / tax policy dirigisme or, if it lets the market drive the development / decisions.

²³ BMWI, *Nachhaltige Energiepolitik*, 34.

²⁴ IEA, 111-113.

²⁵ see CDU, *Maximen für eine zukunftsorientierte Energiepolitik im 21. Jahrhundert* 20-21 (2001), <http://www.cdu.de/politik-a-z/bundesfachausschuesse/energieprogramm.pdf> (09 June 2003); see FDP, 52. Ord. Bundesparteitag der F.D.P.: *Energiepolitisches Programm* (2001), <http://www.fdp-bundesverband.de/pdf/A-051.pdf> (09 June 2003).

²⁶ European Opinion Research Group (EORG), *EUROBAROMETER Energy, 56.2 and 58.0* (2002, each), http://www.gesis.org/en/data_service/eurobarometer/publications/eb_report.htm (09 June 2003).

²⁷ BMWI, *ENERGIE DATEN* 2002, 10, 28.

²⁸ BMWI, *Nachhaltige Energiepolitik*, 38-42.

5. Future Energy Demand

Three different projections are taken to provide an outlook on the future German energy demand till 2020. They are the governmental report “Sustainable Energy Policy to Meet the Needs of the Future” (*Nachhaltige Energiepolitik für eine zukunftsfähige Energieversorgung*), predictions by the IEA till 2010 in “Energy Policies of IEA Countries: Germany 2002 Review”, and reference case projections by the DoE/EIA also till 2020 in the “International Energy Outlook 2003”. All these studies incorporate the phasing out of the German nuclear energy production.

The basic assumptions, e.g. economic and population growth, of all three institutions are similar. The German government expects an average annual economic growth of 1.9% till 2020,²⁹ the IEA an average of 2.0 till 2010,³⁰ and the EIA of 2.2% till 2020 and 2025.³¹ The population is expected to decline from 82 million in 2000 till 2010 to 78.6 million (IEA),³² 81 million (EIA);³³ till 2020 to 80.8 million (German government)³⁴ and/or 80 million (EIA).³⁵

The differences, however, occur in the predictions for the total energy consumption (Figure 2.5), while the share of the different energy types is more or less similar.

²⁹ Ibid., 39.

³⁰ IEA, 135.

³¹ DoE/EIA, *International Energy Outlook* (Washington: National Energy Information Center, 2003), 184.

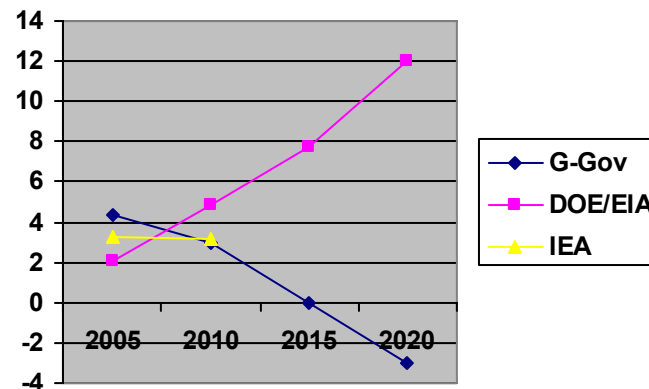
³² IEA, 135.

³³ DoE/EIA, 196.

³⁴ BMWI, *Nachhaltige Energiepolitik*, 39.

³⁵ DoE/EIA, 196.

Figure 2.8: Development of Energy Consumption in % (2000 – 2020)



(After: DOE/EIA, 196; IEA, 133; BMWI, *Nachhaltige Energiepolitik*, 38-41.)

The differences are based on varying assumptions as to how the energy efficiency can be improved. While the German government expects a further improvement till 2020 of 2.1% per year,³⁶ the IEA is slightly less optimistic with an average improvement of 1.65% per year till 2010.³⁷ The IEA's least optimistic prediction is only 1.3% per year till 2025.³⁸ The results are different predictions regarding the electricity consumption and, therefore, production rate. While the German government sees an increase only of 8% by 2020,³⁹ compared to 2000, the IEA expects already a growth until 2010 of 5.45%.⁴⁰ The IEA, moreover, predicts an increase of 28.7% from 2000 to 2020.⁴¹ Figure 2.9 highlights the cleavage, including a projection of the average IEA number until 2020.

³⁶ BMWI, *Nachhaltige Energiepolitik*, 41.

³⁷ IEA, 135.

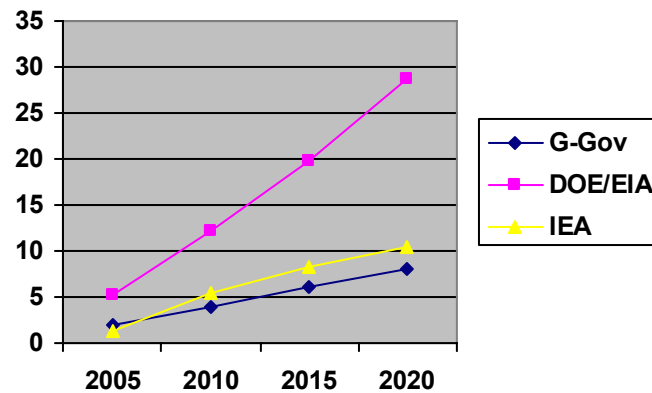
³⁸ DoE/EIA, 5.

³⁹ BMWI, *Nachhaltige Energiepolitik*, 41.

⁴⁰ IEA, 135.

⁴¹ DoE/EIA, 190.

Figure 2.9: Development of German Energy Consumption until 2020



In summary, one result is clear. The energy import dependence will increase in the future. Even in the most optimistic case, when the energy consumption decreases until 2020 by 3%, nuclear energy will be substituted by fossil fuels, upon which import Germany is already highly dependent. The German government expects, in this case, an energy import dependence of 74% in 2020.⁴² Hence, the import dependence in the mid-term can be expected to be at least three-fourth of the future primary energy consumption.

The next chapter describes, in turn, the current supply side of the German energy consumption.

⁴² BMWI, *Nachhaltige Energiepolitik*, 41.

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III. SUPPLY

This chapter examines the supply side of Germany's energy market. The emphasis lies on oil and gas, as coal is not of such future concern, because its sufficient supply is ensured. The conclusion from this analysis is that the current supply structure will inevitably change within this decade. To explain this result oil is the first fuel to be looked at, followed by gas and a more general view towards coal.

When giving an outlook and describing the range of reserves and resources, this is done under the premise of business-as-usual (BAU) conditions. The distinction between reserves and resources is as follows:

Reserves are the quantity that can be recovered from a mineral deposit at current prices with current technology (under existing economic and operating conditions).

Resources are demonstrated quantities that cannot be recovered at current prices with current technology (under existing economic and operating conditions) but might be recoverable in the future, as well as quantities that are geologically possible but not demonstrated.⁴³

A. OIL

As explained in the preceding chapter, Germany's oil supply comes from several countries. This section concentrates on the five largest suppliers (Russia, UK, Norway, Libya and Syria), which represent 78% of the total German oil imports in 2002.

⁴³ See BMWI, *Reserves and Resources*, 33; BP, 4,20.

1. The Russian Federation

In 2001, Russia was the second-largest oil exporter behind Saudi Arabia. Russia's oil exports increased steadily since 1994. In 2001, Russia exported 4.91 million barrels per day (bbl/d). For 2002 and 2003, a further increase was projected with 5.17 and 5.4 million bbl/d.⁴⁴ The largest customers of Russian oil are Western European countries, led by Germany.⁴⁵ In accordance to Russia's energy strategy, "Energy Strategy of the Russian Federation to the Year 2020", Russia plans to increase its oil production till 2020 by 25% (compared to 2000), up to 405 million tons (Mt). Its exports however, are only planned to increase by 8.6%, up to 208.5 Mt, as Russian consumption is expected to rise accordingly.⁴⁶ The IEA expects a lower increase by 11.45% up to 360 Mt, however, with a decrease in Russia's overall oil export of over 12% down to 165 Mt.⁴⁷ The reasons for this assumption are an increase in domestic demands as well, the decline of older fields and insufficient investments in transport capacities and exploitation of newer reserves. While the Russian government estimates investment requirements of \$8 to \$10 billion per year till 2020 in order to meet the projected production quota, only less than \$2 billion in 1999 and under \$5 billion in 2000 were achieved.⁴⁸ Moreover, the statistical range of the Russian oil reserves under the BAU condition is limited too. The official data about reserves and resources are highly unreliable, as they are perceived to be greatly overstated.⁴⁹ The German government estimates Russian oil with 6.6% of the world's reserves and a statistic range of 31 years remaining,⁵⁰ while BP projects a range of only 19.1 years and a share on the global reserves of 4.6%.⁵¹

⁴⁴ DoE/EIA, *Russia: Oil and Gas Exports* (November 2002), <http://www.eia.doe.gov/emeu/cabs/russeexp.html> (09 June 2003).

⁴⁵ IEA, *Russia Energy Survey 2002* (Paris: OECD/IEA, 2002), 91-92.

⁴⁶ Mastepanov, A. *Energy Strategy of the Russian Federation to the Year 2020*, http://europa.eu.int/comm/energy_transport/russia/energy-strategy2020_en.pdf (09 June 2003).

⁴⁷ IEA, 53.

⁴⁸ Ibid., 75-76.

⁴⁹ IEA, 70-71.

⁵⁰ BMWI, *Energie Daten 2002*, 47.

⁵¹ British Petroleum (BP), *BP Statistical Review of World Energy 2002* (London: The Colourhouse, 2002), 4.

Although Russia will remain one of the worlds's largest oil exporters for the next few years, its importance will only remain and increase if it's assumed large resources can be turned into reserves. The prerequisites, however, are either an oil price increase and / or technical development.

2. United Kingdom

The United Kingdom (UK) accounts for 11% of Germany's current oil imports. Although the UK intends to increase its oil exports by 50% in 2005,⁵² its reserves are estimated to last at best only up to 10 years.⁵³ BP and the EIA, however, predict the UK oil reserves with roughly 5 billion barrels,⁵⁴ resulting in a statistical range of only 5.6 remaining years in 2002.⁵⁵ The intended increase in the oil exports corresponds with an intended increase in the oil production of over 18%, up to 3 million bbl/d.⁵⁶ This discrepancy between reserves and export intentions results in the attempt by the British government to generate various incentives for, especially smaller, oil companies to invest in smaller, less efficient oil fields.⁵⁷

Whether these smaller, less efficient oil fields were formerly listed as resources instead of reserves cannot be ascertained. Not is it possible to verify if German estimates of British capacities are more accurate. However, the data indicate that the UK's reserves are on their way to become depleted after this decade and that the oil exports will, therefore, decline anytime after a possible peak in 2005.

⁵² DoE/EIA, *United Kingdom Country Analysis Brief* (February 2003), <http://www.eia.doe.gov/emeu/cabs/uk.html> (09 June 2003).

⁵³ BMWI, *Energie Daten 2002*, 47.

⁵⁴ BP, 4; DoE/EIA, *United Kingdom Country Analysis Brief*.

⁵⁵ BP, 4.

⁵⁶ DoE/EIA, *United Kingdom Country Analysis Brief*.

⁵⁷ Ibid.

3. Norway

In 2001, Norway produced 3.4 million bbl/d of oil. As its own consumption is considerable low, it could export more than 90% of its total production. In 2001, Norway exported around 3.2 million bbl/d, which made Norway not only the world's third-largest oil exporter but also Germany's third most important supplier.⁵⁸ Germany imported more than 1.5 million bbl/d the same year.⁵⁹ Hence, its share on Norway's oil exports was over 46% and remained, therefore, the most important single market. Although BP and the EIA agree in the amount of Norway's reserves, 9.44 billion barrels, they disagree on the statistical range. BP predicts that only roughly 7 years remain, while the EIA expects the Norwegian oil to run out in the 2040s.⁶⁰ The German government on the other hand, estimates with 14 million barrels considerable higher reserves. Germany's expectation is that Norwegian oil will last for only 11 years (2000), much closer to the BP prediction.⁶¹ Taking the 2001 figures, oil production of 3.4 million bbl/d and reserves of 9.44 billion barrels, Norway produced 1.241 billion barrels. This would mean that, under BAU conditions, Norway's reserves run out in 2008 / 2009 (7.6 years). Unless new reserves are discovered anytime soon, Norway will cease to be an oil exporter at the end of this decade.

4. Libya

Libya's proven oil reserves are estimated to be around 29 billion barrels.⁶² Nevertheless, Libya exported only 438 million barrels (1.2 million bbl/d) in 2001. Around 90% of it went to Europe. Italy is its by far largest customer (42.25%) followed by Germany with a 17.33% (208,000 bbl/d) share. The low production and export rates are based on the former United Nations (UN) and US sanctions and the performance of

⁵⁸ DoE/EIA, *Norway Country Analysis Brief* (September 2002), <http://www.eia.doe.gov/emeu/cabs/norway.html> (09 June 2003).

⁵⁹ BMWI, *Energie Daten 2002*, 19.

⁶⁰ DoE/EIA, *Norway Country Analysis Brief*, BP, 4.

⁶¹ BMWI, *Energie Daten 2002*, 47.

⁶² Ibid.; BP, 4.

the state run economy as well. Nevertheless, Libya is trying to attract foreign investors since these sanctions are mainly lifted and is planning to increase its production capacity to 2 million bbl/d within 5 years. Progress in this direction has been slow, since the bureaucracy and the contract awarding process are inefficient.⁶³ With its considerable reserves and attractive geological conditions, Libya could attract sufficient foreign investment once its bureaucratic behavior improved. Both, BP and the BMWI predict the statistical range of Libyan oil with more than 55 years.⁶⁴

5. Syria

In 2002, Germany imported 55.2 million barrels (7.24 Mt) oil from Syria.⁶⁵ Syria is estimated to have produced only 525,682 bbl/d (192 million barrel) in 2002.⁶⁶ This would mean that Syria exported over 27% of its total oil production to Germany. However, Syria's reserves are predicted to be only 2.5 billion barrels.⁶⁷ Hence, Syria's reserves will be depleted in the middle of the next decade. As oil production is assumed to steadily decline, its consumption, because of its population growth, is expected to do the opposite. Syria will, therefore, become a net importer within this decade.⁶⁸

⁶³ DoE/EIA, *Libya Country Analysis Brief* (July 2002), <http://www.eia.doe.gov/emeu/cabs/libya.html> (09 June 2003).

⁶⁴ BP, 4; BMWI, *Energie Daten 2002*, 47.

⁶⁵ BAFA, *EnergieINFO R12-2002*.

⁶⁶ DoE/EIA, *Syria Country Analysis Brief* (March 2003), <http://www.eia.doe.gov/emeu/cabs/syria.html> (09 June 2003).

⁶⁷ BP, 4.

⁶⁸ DoE/EIA, *Syria Country Analysis Brief*.

B. GAS

Chapter II described that over 94.5% of Germany's total gas imports are concentrated on only three countries: Russia, Norway and The Netherlands. This section examines production and exports in those three countries:

1. The Russian Federation

Russia is Germany's largest gas provider with a share of 45% on its imports. Germany, in turn, is Russia's largest single customer. In 2000, 18.5% of Russia's gas exports went to Germany, and in 2001, 17.2%. With 6.7 trillion cubic feet (Tcf), Russia is already the world's largest gas exporters, Russia is expected to increase its export to 7.5 Tcf in 2005.⁶⁹ All Russian gas exports so far have gone to Europe and the Commonwealth of Independent States (CIS) and no changes are expected at least until 2010. Europe, including Turkey and the Baltic states, is Russia's main destination for its gas exports. Over 60% of Russia's exports went to Europe in 2000 and 2001.⁷⁰ The Russian government expects the gas production as well as the export to increase around 20% until 2020, to 700 billion cubic meters (Bcm) and 234 Bcm respectively.⁷¹ Russia owns reserves of around 47-48 Tcm, which gives it a share of roughly 30% on the world's total reserves and makes it by far the largest "gas nation". These reserves provide for a statistical range of at least a further 80 years.⁷² Hence, the increase in production and exports should be manageable. However, the gas sector suffers the same imponderables as the oil sector. These are, besides the monopoly of Gazprom, the insufficient investments. An average of more than \$8 billion per year is required until 2020 in order to meet the intended figures. As Gazprom is still responsible for over 90% of Russia's total gas production, its share in investments is required to be in the same dimension. In 1999 and 2000, Gazprom's investments are estimated to be only \$3.1 to

⁶⁹ DoE/EIA, *Russia: Oil and Gas Exports*.

⁷⁰ Ibid.; IEA, 134-137.

⁷¹ Mastepanov.

⁷² BMWI, *ENERGIE DATEN 2002*, 48; IEA, 111; BP, 20.

\$3.6 billion.⁷³ Moreover, Gazprom cut its investments for field exploration to \$453 million.⁷⁴

2. Norway

Behind Russia, Norway is Europe's second-largest gas exporter. The gas export in 2002 is assumed to be between 1.9 and 2.3 Tcf.⁷⁵ In 2001, Germany imported around 0.77 Tcf and for 2002 a slight increase is forecast.⁷⁶ This would result in a German share on Norwegian gas exports of between 35% and 40%. Norway's gas reserves are predicted to be a total of 44 Tcf.⁷⁷ Although Norwegian domestic consumption is expected to increase over the next years, it does so on a relative low level as the current consumption is limited.⁷⁸ Hence, the overwhelming amount of Norwegian reserves is available for export. The reserves are predicted to last at least 22 years,⁷⁹ while the BMWI assumes a statistical range of over 50 years, because it expects far larger reserves than BP and EIA.⁸⁰

⁷³ IEA, 120.

⁷⁴ DoE/EIA, *Russia Country Analysis Brief*, (November 2002), <http://www.eia.doe.gov/emeu/cabs/russia.html> (09 June 2003).

⁷⁵ DoE/EIA, *Norway Country Analysis Brief*.

⁷⁶ BMWI, *ENERGIE DATEN 2002*, 23.

⁷⁷ DoE/EIA, *Norway Country Analysis Brief*; BP, 20.

⁷⁸ DoE/EIA, *Norway Country Analysis Brief*.

⁷⁹ BP, 4.

⁸⁰ BMWI, *ENERGIE DATEN 2002*, 48.

3. The Netherlands

In 2000, the Netherlands produced 2.6 Tcf natural gas and exported 866 Bcf of it.⁸¹ Approximately 590 Bcf were exported to Germany, a quota of 68%.⁸² Germany is, therefore, by far the Netherlands' most important customer. Although the Dutch government decided to limit gas production, in order to keep reserves for the future, the overall situation is not expected to change.⁸³ Both the BMWI and BP expect Dutch reserves to last a further 25 years.⁸⁴ Hence, the Netherlands can remain an important gas supplier for Germany for at least a further decade.

C. COAL

The forecasts for coal (hard and lignite) differ, depending to which extent known deposits are considered reserves or resources. An additional obstacle is that the publications define regions differently, e.g. combining Africa and Middle East or distinguishing between the Asia-Pacific region and landlocked Asia. Nevertheless, the predictions for how long the coal will last are similar and the results are equally conclusive. The world coal reserves are expected to last at least over 160 years,⁸⁵ while most forecasts are predicting more than 210 years,⁸⁶ with the least reserves in the Asian Far East and Europe. However, the predictions for these regions are still at least 100 years.⁸⁷ As most world regions have reserves for at least 160 years and these are much diversified, there will be no constraints for Germany on future access and imports of coal. Hence, coal is of much lesser concern than oil and gas.

⁸¹ DoE/EIA, *North Sea* (February 2002), <http://www.eia.doe.gov/emeu/cabs/northsea.html> (09 June 2003).

⁸² BMWI, *ENERGIE DATEN* 2002, 23.

⁸³ DoE/EIA, *North Sea*.

⁸⁴ BMWI, *ENERGIE DATEN* 2002, 48; BP, 20.

⁸⁵ BMWI, *ENERGIE DATEN* 2002, 49.

⁸⁶ BP, 30.; DoE/EIA, *International Energy Outlook*, 80.

D. SUMMARY

As discussed in chapter I, the German oil and gas demand will not decline until 2020. Hence, the oil supply situation for Germany becomes complex already in this decade. Since oil imports from the UK and Syria are expected to cease after 2005, 18% of the current oil supply has to be substituted within this decade. Russia might not be available to provide the amount necessary as its current investments are far below the requirements needed to meet the goals of the Russian energy strategy. The gas situation is somewhat less urgent as a supply shift has to take place only after 2010, when the Norwegian and Dutch gas reserves will cease to satisfy the export demand. However, some critical thinking on Germany's gas supply after 2010 is presently necessary. Therefore, the next chapter discusses alternative supply regions after 2010.

⁸⁷ BMWI, *ENERGIE DATEN 2002*, 49.; BP, 30.

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IV. ALTERNATIVE SUPPLY REGIONS

A. GLOBAL ENERGY DEVELOPMENT AFTER 2010

In order to evaluate the possibility of alternative energy supplies for Germany, we must first take a look at the overall global energy development. The first issue to be addressed is that of economic and population forecasts, as these two factors are the primary determinants of energy demand.⁸⁸ This will be followed by the a discussion of the world's distribution of oil and gas reserves / resources. The third step will then be the examination of possible energy suppliers after 2010. As described in the previous chapter, coal consumption will remain steady and the supply uncritical. Therefore, coal will not be viewed in this chapter.

1. World Population and Economic Development

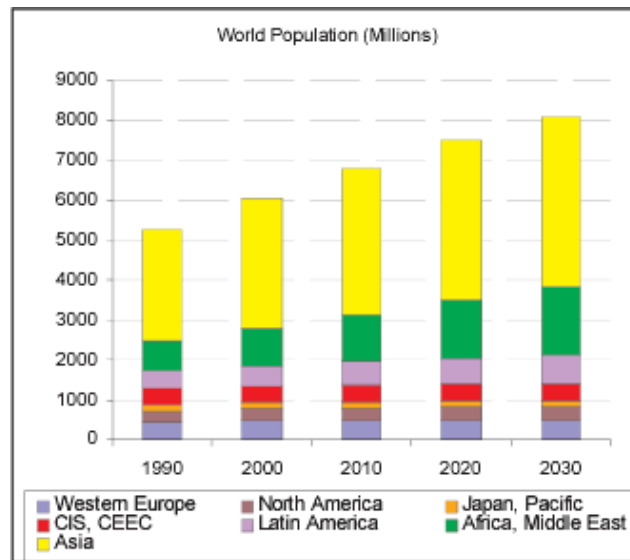
The global population continues to experience growth, although the rate of increase is slowing down.⁸⁹ Most remarkably, however, is the drastic shift away from the industrialized countries to the developing countries. The result is an increasing share for the developing countries on the world's population (Figure 4.1). Together with an increasing GDP, this will lead to higher industrialization, urbanization and transportation, hence, stimulating the increase of energy consumption as well. Already in 2010, the developing countries will share slightly 40% of the global energy demand. Moreover, China and East Asian countries will primarily drive this demand.⁹⁰

⁸⁸ Organization for Economic Cooperation and Development (OECD), *Energy: The Next Fifty Years* (Paris: OECD, 1999), 32-33.

⁸⁹ European Commission (EC), *World Energy, Technology and Climate Policy Outlook (WETO) 2030* (Brussels: Directorate-General for Research, 2003), 14.

⁹⁰ Martin, W., Imai, R., Steeg, H., *Maintaining Energy Security in a Global Context* (New York, Paris, Tokyo: The Trilateral Commission, 1996), 50-51.

Figure 4.1: World Population by Region (- 2030)



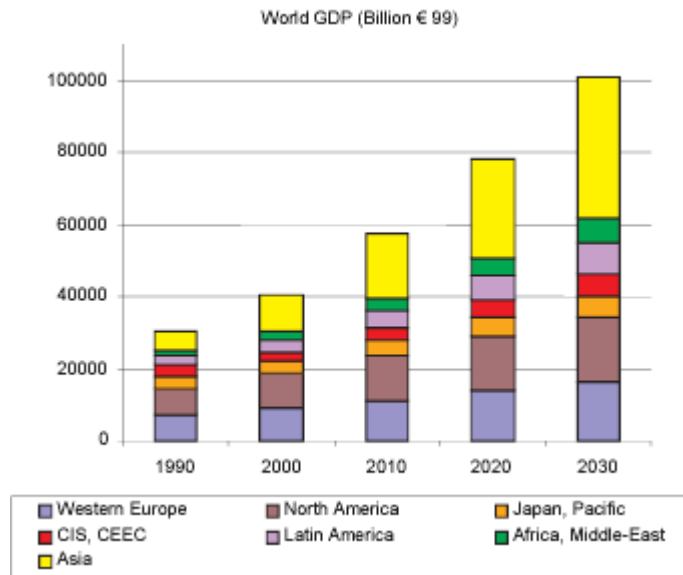
(From: European Commission (EC), *World Energy, Technology and Climate Policy Outlook (WETO) 2030* (Brussels: Directorate-General for Research, 2003), 16.)

The world economy is expected to grow by approximately 3% per year for the next 25 to 30 years.⁹¹ Like the population growth, the shares of the world GDP for the developing countries will also increase from roughly 19% in 2001 to roughly 27% in 2025, once again driven primarily by China and other East Asian countries (Figure 4.2).⁹²

⁹¹ EC, 15; DOE/EIA, *International Energy Outlook*, 8.

⁹² DOE/EIA, *International Energy Outlook*, 8.

Figure 4.2: World GDP (- 2030)



(From: EC, 18.)

The combined effects of persisting population and economic growth will consequently lead to a further spike in world energy consumption (Figure 4.3). Most forecasts anticipate a significant growth in the world energy consumption, while the importance of oil, gas and coal for the global energy consumption is even expected to increase; up to 88% compared to 81% in 2001.⁹³ The EIA predicts an increase in the global energy consumption of 58.5% from 2001 to 2025.⁹⁴ The European Commission (EC) forecasts a similar increase of 70% between 2000 and 2030.⁹⁵ The German *Mineralölwirtschaftsverband*, an association of the oil sector related companies, predicts a similar development with an increase of fossil fuels of 65% by 2020, compared to that of 1995. In this forecast, fossil fuels will primarily be responsible for 95% of the consumption growth.⁹⁶

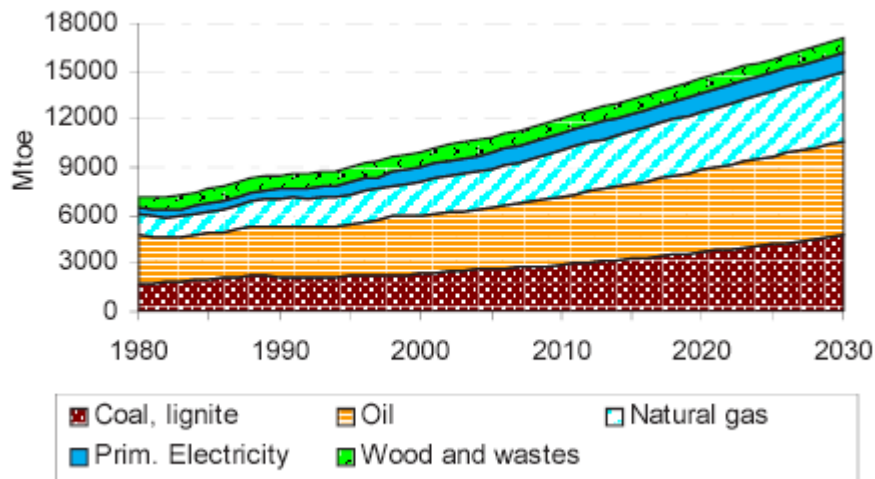
⁹³ EC, 24.

⁹⁴ DOE/EIA, *International Energy Outlook*, 7.

⁹⁵ EC, 24.

⁹⁶ Mineralölwirtschaftsverband (MWV), *MineralölForum: Energiemarkt im Wandel*, 8.

Figure 4.3: World Energy Consumption (- 2030)

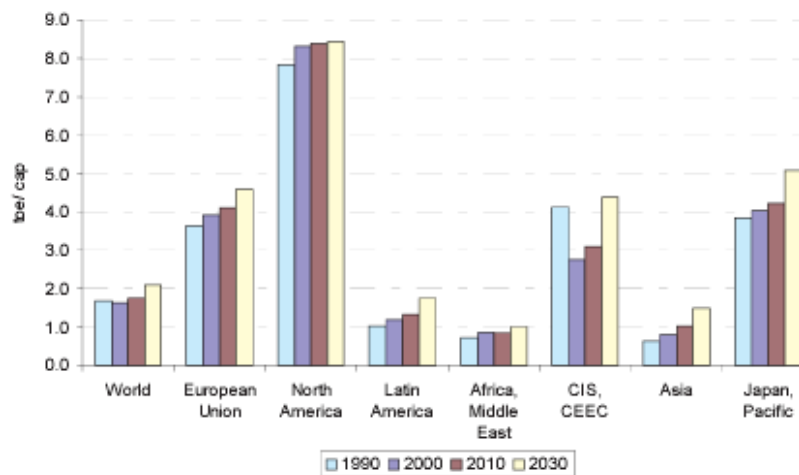


(From: EC, 24.)

It is expected that the energy intensity and the ratio of energy consumption to the GDP will decrease (therefore improve) worldwide over the two decades. This will occur more efficiently in the industrialized countries than in the developing countries. Although the improvement rate of the developing countries is higher, compared to the industrialized countries, the required energy per GDP achievement will remain higher for the foreseeable future in the developing countries.⁹⁷ Nevertheless, the per capita consumption of energy will remain higher in the industrialized countries, at least until 2030 (Figure 4.4). Henceforth, the overall energy demand will remain high.

⁹⁷ OECD, 51-52.

Figure 4.4: Energy Consumption per Capita (- 2030)



(From: EC; 30.)

Having described the global energy development, the next section will address the world distribution of both oil and gas reserves / resources.

2. Distribution of Oil and Gas

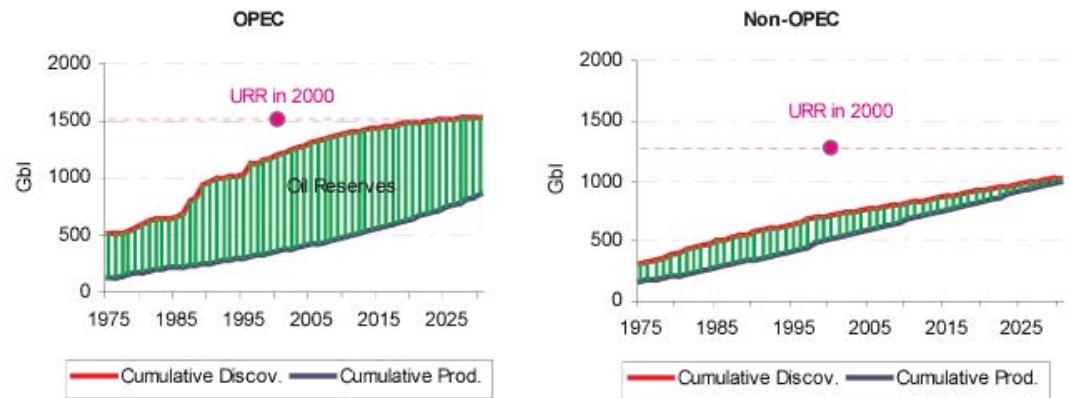
As illustrated in the previous section, oil remains the largest energy source in the mid-term perspective. The EIA expects oil to hold a steady share of 38% in 2025 compared to 39% in 2001.⁹⁸ However, OPEC⁹⁹ will increase its importance over the upcoming decades, as the production closes the gap to the respective reserves and resources of non-OPEC states (Figure 4.5). The EC predicts a decline in the oil resources by 84% in non-OPEC states and by 19% within the OPEC. The OPEC will be responsible for 60% of total oil supply in 2030, of which 46% will be provided by the Middle East member states (Figure 4.6). Moreover, as of 2030, OPEC will hold 95% of the global oil reserves, compared to the current 80%. An additional advantage for the

⁹⁸ DOE/EIA, *International Energy Outlook*, 2.

⁹⁹ Iran, Iraq, Kuwait, Qatar, Saudi-Arabia, UAE, Algeria, Libya, Nigeria, Indonesia, Venezuela.

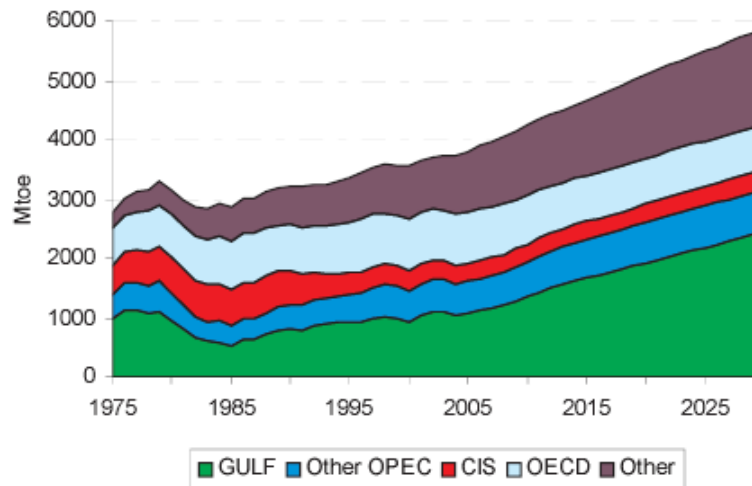
Middle East OPEC member states is that the oil reservoirs in the Gulf region are fairly easy to exploit, contrary to most of the remaining global reservoirs.¹⁰⁰

Figure 4.5: OPEC and non-OPEC Conventional Oil Resources (- 2030)



(From: EC, 41.)

Figure 4.6: World Oil Production (- 2030)

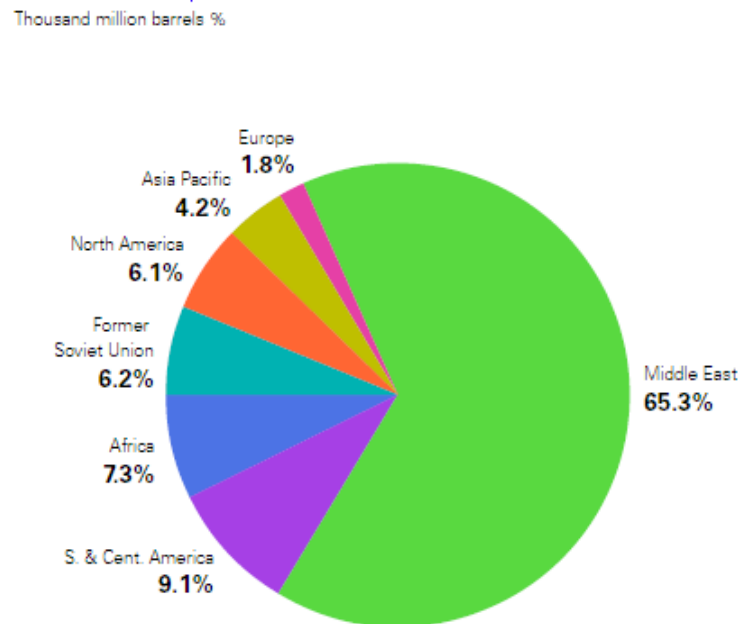


(From: EC, 42.)

¹⁰⁰ EC, 40-41.

Figure 4.7 highlights the current distribution of oil reserves, which are already concentrated in the Middle East.¹⁰¹

Figure 4.7: Distribution of Proved Oil Reserves 2001

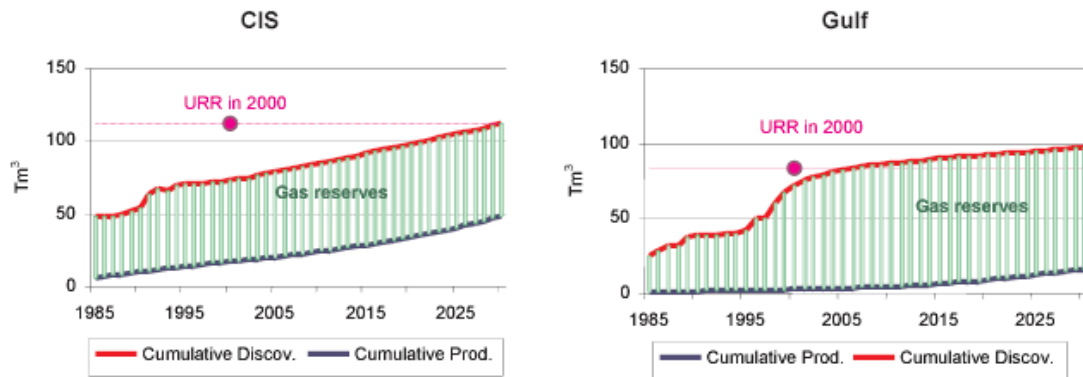


(From: British Petroleum (BP), *BP Statistical Review of World Energy 2002* (London: The Colourhouse, 2002), 5.)

¹⁰¹ BP, 4.

Unlike oil, gas reserves are not expected to deplete anytime soon. According to BP statistics, the worldwide statistical range of gas will ensure supply for more than 60 years.¹⁰² The share on the total primary energy consumption will grow from the current 23% to 28% in 2025, becoming the second largest source for the overall energy consumption. This effect will be triggered primarily by the increasing gas-based electricity production, which reflects the growing electricity demand.¹⁰³ The gap between production and resources of the main contributors, the Commonwealth of Independent States (CIS) and the Gulf region, will not close significantly until at least 2030 (Figure 4.8).¹⁰⁴ In 2001, the CIS and the Middle East region accounted for more than 72% of the global gas reserves (Figure 4.9).¹⁰⁵ Moreover, the EC forecasts a growth in reserves by 14% until 2030 for these two regions, increasing their share of the global gas reserves further.¹⁰⁶

Figure 4.8: Gas Resources in the CIS and the Gulf (- 2030)



(From: EC, 43.)

¹⁰² Ibid., 20.

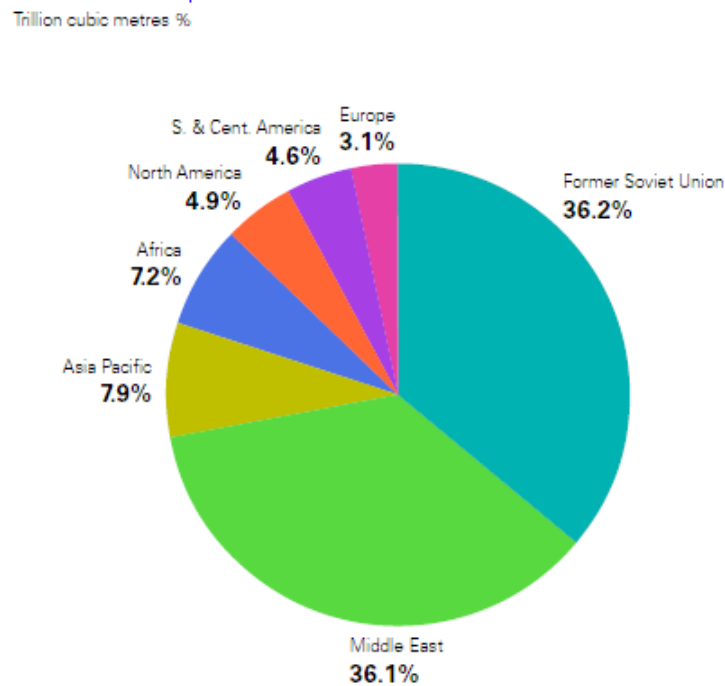
¹⁰³ DOE/EIA, *International Energy Outlook*, 3.

¹⁰⁴ EC, 42-43.

¹⁰⁵ BP, 20.

¹⁰⁶ EC, 42-43.

Figure 4.9: Distribution of Proved Gas Reserves 2001

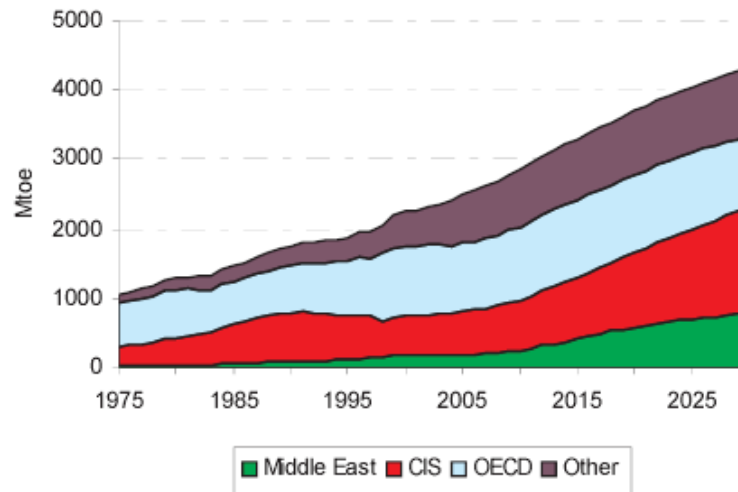


(From: BP, 21.)

Consequently, while there will be only a slight increase of gas production in the OECD countries, the increase for the CIS and Middle East region will be far more significant. The CIS suppliers will be able to increase their gas production from 28% in 2000 to more than 40% in 2030. The CIS, together with Middle East countries, will be responsible for more than 50% of the global gas production in 2030 (Figure 4.10).¹⁰⁷

¹⁰⁷ Ibid.43.

Figure 4.10: World Gas Production (- 2030)



(From: EC, 44.)

3. Alternative Suppliers after 2010

The previous section highlighted the fact that besides the Gulf region, only few potential oil suppliers will remain during the coming decades. Russia will not be discussed in this section, as the country was already discussed in Chapter III. The first potential oil alternatives to be viewed are those outside the Middle East, namely Latin America and Caribbean Sea region, North America, Africa, Asia Pacific and the Caspian Sea region (excluding Russia). This section will conclude with a more general description of the Middle East.

a. Latin America and Caribbean Sea Basin

Latin America is defined in this thesis as the Central American states, excluding Mexico, and the South American states. The Caribbean Sea basin will include all Caribbean islands, including the Bahamas.

By far, the largest oil and gas reserves in this region are owned by Venezuela. In 2003, the Venezuelan oil reserves accounted for more than 7.5% (77.8

billion barrels) of the world's proven reserves, which are the largest outside the Middle East. In 2002, Venezuela produced 2.9 million bbl/d, of which more than 84% were exported. Only a small share (160,000 bbl/d) was exported to Central American and Caribbean states, the vast majority was destined for the USA (1.4 million bbl/d). Additionally, some of the oil exports to the Netherland Antilles and U.S. Virgin Islands are refined there and then re-exported to the US.¹⁰⁸ With a predicted statistical range of more than 67 years¹⁰⁹ and its export capacities, even if the domestic consumption will rise, Venezuela will remain a major oil supplier for the next decades, particularly for the US. With proven gas reserves of 148 Tcf, as of 2003, these are the second largest on the American continent behind the US. The current production rate is very low. In 2001, Venezuela produced only 1.1 Tcf, all for domestic consumption.¹¹⁰ Although Venezuela has the potential to become a larger gas exporter, huge investments are required to expand the existing small gas producing industry.

The second largest proven oil reserves, with 8.5 billion barrels, are located in Brazil. However, Brazil produced only 1.6 million bbl/d in 2001, but consumed 2.2 million bbl/d. Hence, more than one-fourth of the domestic consumption had to be imported. Although the oil production is expected to grow, the domestic consumption is also expected to grow in the coming years.¹¹¹ As the statistical range of Brazil's oil is only forecast with 17.5 years,¹¹² Brazil will foreseeable never become a net exporter. The current proven gas reserves are only 7.8 Tcf and the current production rate is not sufficient enough to meet the domestic demand. The domestic consumption is expected

¹⁰⁸ DoE/EIA, *Venezuela Country Analysis Brief* (May 2003),
<http://www.eia.doe.gov/emeu/cabs/venez.html> (09 June 2003).

¹⁰⁹ BMWI, *ENERGIEDATEN 2002*, 47.

¹¹⁰ DoE/EIA, *Venezuela Country Analysis Brief*.

¹¹¹ DoE/EIA, *Brazil Country Analysis Brief* (July 2002),
<http://www.eia.doe.gov/emeu/cabs/brazil.pdf> (09 June 2003).

¹¹² BP, 4.

to increase further. However, as recent explorations have concentrated on oil, there might be the possibility of additional gas fields.¹¹³

Argentina has the third-largest proven oil reserves in Latin America, with 3.0 billion barrels.¹¹⁴ Currently, Argentina is exporting slightly more than 300 million bbl/d to its South American neighbors.¹¹⁵ However, as the reserves will last only until the beginning of the next decade,¹¹⁶ Argentina will not play an important role in the oil market. More potential exists within Argentine gas supply. Argentina possesses the second largest proven gas reserves in Latin America, with 27.5 Tcf.¹¹⁷ Moreover, it is expected that its resources are significantly higher. Since 1999, Argentina, already Latin America's largest gas producer, has production capacities that are currently exceeding domestic consumption as well as export.¹¹⁸ Hence, Argentina's importance as a natural gas supplier will at least increase regionally.

With estimated gas reserves between 24 Tcf and probably more than 52 Tcf, Bolivia has the potential to become an important gas supplier too, although much development and investments are still required.¹¹⁹ According to these numbers, Bolivia would own up to 0.95% of the global natural gas reserves.

¹¹³ DoE/EIA, *Brazil Country Analysis Brief*.

¹¹⁴ BP, 4.

¹¹⁵ DoE/EIA, *Argentina Country Analysis Brief* (October 2002), <http://www.eia.doe.gov/emeu/cabs/argentina.html> (09 June 2003).

¹¹⁶ BP, 4.

¹¹⁷ Ibid., 20.

¹¹⁸ DoE/EIA, *Argentina Country Analysis Brief*.

¹¹⁹ DoE/EIA, *Bolivia Country Analysis Brief* (August 2002), <http://www.eia.doe.gov/emeu/cabs/bolivia.html> (09 June 2003).

b. North America

The term North America includes, besides Canada and the US, the third North American Free Trade Area (NAFTA) member --Mexico.

The predictions for Canada's proven oil reserves vary between 4.9 billion barrels¹²⁰ and 6.6 billion barrels;¹²¹ nevertheless, with a production rate of 2.9 million bbl/d¹²², the Canadian reserves will become depleted by 2010. Consequently, although Canada is still the third-largest crude oil supplier for the US, behind Saudi-Arabia and Mexico, the importance of Canadian oil for the US will diminish drastically within this decade. The situation of Canada's gas is similar to that of the oil sector. Canada is currently the second-largest natural gas exporter after Russia and accounts for reserves of 59.7 Tcf. However, with the current production rate of 6.5 Tcf, its reserves will be depleted soon after 2010. There is hope that further reserves will be discovered in the far northwest sector of Canada and that the situation will change accordingly.¹²³

In autumn 2002, Mexico revised its oil and gas reserve calculations in order to meet the common international standards, especially for that of the US Security and Exchange Commission (SEC). The result was a dramatic decrease in both types of reserves. The proven oil reserves were now merely 12.6 billion barrels instead of 26.9 billion barrels and the proven gas reserves were revised from 29.5 to 8.8 Tcf. The oil reserves will, therefore, become depleted soon after 2010 and the gas reserves between 2008 and 2010. Hence, although Mexico is currently the second-largest oil supplier for the US, this will change rapidly especially as the domestic energy consumption is on a steady rise. Also in the case of Mexico some hope might exist, as there are expectations for considerable oil and gas resources.¹²⁴

¹²⁰ DoE/EIA, *Canada Country Analysis Brief* (December 2002), <http://www.eia.doe.gov/emeu/cabs/canada.html> (09 June 2003).

¹²¹ BP, 4.

¹²² DoE/EIA, *Canada Country Analysis Brief*.

¹²³ Ibid.

¹²⁴ DoE/EIA, *Mexico Country Analysis Brief* (February 2003), <http://www.eia.doe.gov/emeu/cabs/mexico.pdf> (09 June 2003).

The United States and its world largest energy demand are dominating (not only) the North American energy market. The EIA, in its reference case, forecasts a steady growth of energy consumption for the US. Between 2001 and 2020, the average annual increase is predicted at 1.5%, with an overall total of 30%.¹²⁵ The oil production rate, however, is expected to grow only 0.22% per year until 2025 (approx. 29 million bbl/d).¹²⁶ Gas production is likewise expected not to hold up with growing domestic demand during the same timeframe.¹²⁷ Hence, oil and gas has to be imported to a larger extent to meet the growing US demand. In its reference case, the EIA predicts an increase of oil imports between 2001 and 2025 by at least 63.3%.¹²⁸ The imports of natural gas will also rise, by approximately two-third in the same timeframe, from currently more than 3 Tcf to over 5 Tcf.¹²⁹

c. Africa

The most important energy producers of the African continent are Algeria, Egypt, Libya and Nigeria. As Libya was already discussed in the previous chapter, it is not included in the examination for this section.

Although Algeria possesses the largest proven gas reserves and third-largest proven oil reserves of the African states, even larger resources are expected in both cases as there were relatively few exploration operations in the last few years. The current proven oil reserves are at 9.2 billion barrels or 1.2 billion tons.¹³⁰ The German Ministry of Economy (BMWi) estimates the proven reserves with 1.8 billion tons (13.8 billion barrels).¹³¹ Over 80% of Algeria's oil production is exported, primarily to

¹²⁵ DoE/EIA, *Annual Energy Outlook 2003: With Projections to 2025* (Washington: Office of Integrated Analysis and Forecasting, 2003), 3.

¹²⁶ Ibid., 82.

¹²⁷ Ibid., 76.

¹²⁸ Ibid., 82.

¹²⁹ Ibid., 76.

¹³⁰ BP, 4.

¹³¹ BMWI, *ENERGIEDATEN 2002*, 47.

Europe, but also to the US. Even if Algeria increases its domestic consumption, it intends to increase its production capacities as well, from the current 1.1 million bbl/d to 2 million bbl/d in 2012 and will therefore remain a net exporter.¹³² Nevertheless, the strategic range will be at least 2 decades.¹³³ As mentioned earlier, Algeria is predicted to have the largest African proven gas reserves, 160 Tcf, which is 2.9% of the world proven reserves as well.¹³⁴ The Algerian state owned oil and gas monopoly, Sonatrach, expects the existence of additional 44 Tcf in gas reserves. The gas production is also primarily exported, nearly exclusively to Europe where Algeria already accounts for 20% of all European Union (EU) gas imports.¹³⁵ The proven reserves alone guarantee a strategic range of more than 50 years in gas production.¹³⁶

Although the Egyptian oil production still meets the domestic demand,¹³⁷ it is already declining and it is predicted that its proven oil reserves will not exceed 2015.¹³⁸ The situation for the natural gas sector is much more positive. In October 2002, the Egyptian Government revised the amount of proven gas reserves from 35.2 Tcf to 58.5 Tcf, while anticipating an additional 62.5 Tcf as probable reserves. Consequently, Egypt intends to increase its gas exports, predominantly that of liquefied natural gas (LNG), 5 Bcf/d by 2007.¹³⁹ The natural gas statistical range will therefore increase to at least more than 40 years or possibly over 60 years, taking the new figures into consideration.

¹³² DoE/EIA, *Algeria Country Analysis Brief*, (January 2003), <http://www.eia.doe.gov/emeu/cabs/algeria.pdf> (09 June 2003).

¹³³ BMWI, *ENERGIEDATEN 2002*, 48.

¹³⁴ BP, 20.

¹³⁵ DoE/EIA, *Algeria Country Analysis Brief*.

¹³⁶ BMWI, *ENERGIEDATEN 2002*, 48.

¹³⁷ DoE/EIA, *Egypt Country Analysis Brief* (January 2003), <http://www.eia.doe.gov/emeu/cabs/egypt.pdf> (09 June 2003).

¹³⁸ BP, 4.

¹³⁹ DoE/EIA, *Egypt Country Analysis Brief*.

While the BMWI prediction of Nigeria's proven oil reserves is of 22.5 billion barrels,¹⁴⁰ the OPEC prediction is at 31.5 billion barrels.¹⁴¹ In that the oil production rate in 2002 was approximately 0.767 billion barrels, the statistical range of the Nigerian reserves vary therefore from less than 30 years to over 40 years. If the Nigerian government is correctly expecting more than 40 billion barrels of proven reserve, this would increase the statistical range accordingly.¹⁴² The proven gas reserves are commonly predicted at 124 Tcf, the second largest in Africa and the ninth-largest worldwide.¹⁴³ Due to the lack of an appropriate gas industry and infrastructure, Nigeria is using only slightly more than 10% for direct energy consumption. The remainder (75%) is either flared or re-injected into oil reservoirs.¹⁴⁴ Hence, the potential exists for Nigeria to become an important global gas supplier.

d. Asia Pacific Region

The only net oil exporters in the Asia Pacific Region are Malaysia and Indonesia. Both, however, will become net oil importers around 2010. The current proven oil reserves in Indonesia are at 5 billion barrels.¹⁴⁵ Unfortunately, these reserves are already mature and with an average production rate of nearly 1.2 million bbl/d, the Indonesian oil fields will become depleted by 2010, and Indonesia will turn into a net oil importer within this decade.¹⁴⁶ The situation for Malaysia is similar. Malaysia's proven reserves of 3 billion barrels will be depleted around 2010.¹⁴⁷ The average oil production

¹⁴⁰ BMWI, *ENERGIEDATEN 2002*, 47.

¹⁴¹ DoE/EIA, *Nigeria Country Analysis Brief* (March 2003),
<http://www.eia.doe.gov/emeu/cabs/nigeria.pdf> (09 June 2003).

¹⁴² Ibid.

¹⁴³ BMWI, *ENERGIEDATEN 2002*, 48.

¹⁴⁴ DoE/EIA, *Nigeria Country Analysis Brief*.

¹⁴⁵ BP, 4.

¹⁴⁶ DoE/EIA, *Indonesia Country Analysis Brief* (January 2002),
<http://www.eia.doe.gov/emeu/cabs/indonesia.html> (09 June 2003).

¹⁴⁷ BP, 4.

rate of the previous years ranged between 650,000 bbl/d and 730,000 bbl/d; hence, Malaysia will become a net importer close to 2010.¹⁴⁸

The perceptions of the gas sector, on the contrary, are much better. Malaysia's proven gas reserves are at 75 Tcf.¹⁴⁹ The overall gas production in 2000 was 1.5 Tcf, of which 0.74 Tcf were LNG exports (ca. 15% of total world LNG exports) predominately to the leading Asian industrialized countries. Additional LNG facilities are already under construction, thus, Malaysia will be able to increase its exports of LNG further.¹⁵⁰ Nevertheless, the statistical range will be at least 50 years.¹⁵¹

Indonesia, with 92.5 Tcf, has the region's largest proven gas reserves.¹⁵² Additionally, it is expected that Indonesia's gas resources are considerable, yet it lacks any concrete figures. Already, by far the world's largest LNG exporter, Indonesia intends to double its LNG export capacities in the upcoming years.¹⁵³ The statistical range, however, will remain for approximately 50 years.¹⁵⁴

The second-largest proven gas reserves, 90 Tcf, in the Asian Pacific Region are located within the Australian territory.¹⁵⁵ However, Australia produced only 1.12 Tcf in 2001, of which a small amount--that of 365,000 Bcf were exported. The development of the Australian gas industry is only at the beginning; however, it will advance in the future with great export potential also in the LNG sector.¹⁵⁶

China is already the world third-largest oil consumer, following the US and Japan. As the economic activities steadily increase, the oil consumption is expected

¹⁴⁸ DoE/EIA, *Malaysia Country Analysis Brief* (July 2002), <http://www.eia.doe.gov/emeu/cabs/malaysia.pdf> (09 June 2003).

¹⁴⁹ BP, 20.

¹⁵⁰ DoE/EIA, *Malaysia Country Analysis Brief*.

¹⁵¹ BMWI, *ENERGIEDATEN 2002*, 48.

¹⁵² BP, 20.

¹⁵³ DoE/EIA, *Indonesia Country Analysis Brief*.

¹⁵⁴ BMWI, *ENERGIEDATEN 2002*, 48.

¹⁵⁵ BP, 20.

¹⁵⁶ DoE/EIA, *Australia Country Analysis Brief* (May 2002), <http://www.eia.doe.gov/emeu/cabs/australi.pdf> (09 June 2003).

to grow as well. The consumption forecast for 2020 is 10.5 million bbl/d, which would make China the second-largest oil consumer at that time. Despite that China has large gas reserves, 48.3 Tcf,¹⁵⁷ of its own it does not produce enough to match domestic demand, although gas accounts for only 3% of China's energy consumption. Hence, already a gas importer, China's gas demand will increase further as energy consumption is expected to at least triple until 2010.¹⁵⁸

e. Caspian Sea Region

The only countries to be discussed under this topic are Azerbaijan, Kazakhstan and Turkmenistan, as Russia was already discussed in Chapter II separately. Iran will be viewed as part of the Middle East. However, due to its proximity, historic and contemporary ties, (i.e. FSU and CIS), Uzbekistan is viewed as part of the Caspian Sea region as well.

Azerbaijan's proven oil reserves are accounted for 0.7% of the world's reserves, which are at least 7.0 billion barrels.¹⁵⁹ In 2001, Azerbaijan produced only 311,000 bbl/d compared to an estimated 500,000 bbl/d during the Soviet era. Nevertheless, as the production has grown steadily over the previous years and foreign investment continues to flow into the country, further production growth can be expected. This is the case also for Azerbaijan's oil export. In 2001, Azerbaijan exported 175,200 bbl/d, or over 56% of its total production. With the constant flow of investments and the ongoing pipeline projects to Turkey via Georgia an increasing oil export is predicted.¹⁶⁰ Azerbaijan shares a similar part on the world gas reserves in oil. The proven gas reserves estimate is about 30 Tcf.¹⁶¹ The gas production, however, is not in accordance with the

¹⁵⁷ BP, 20.

¹⁵⁸ DoE/EIA, *China Country Analysis Brief* (June 2002),
<http://www.eia.doe.gov/emeu/cabs/china.pdf> (09 June 2003).

¹⁵⁹ BP, 4.

¹⁶⁰ DoE/EIA, *Azerbaijan Country Analysis Brief* (June 2002),
<http://www.eia.doe.gov/emeu/cabs/azerbjan.pdf> (09 June 2003).

¹⁶¹ BP, 20.

respective potential, because of the non-existing gas industrial infrastructure. In 2000, Azerbaijan produced only 200 Bcf. Moreover, in 2001, Azerbaijan had to import 125 Bcf from Russia. Although the build up / refurbishing of the Azerbaijani gas industry will take time, based on the current investment activities also in the gas sector, Azerbaijan is expected to become a net gas exporter shortly after 2010.¹⁶²

The country with the most potential, in terms of oil and gas supply, is Kazakhstan. The German BMWI predicts Kazakhstan's proven oil reserves at more than 21 billion barrels, which is 1.9% of the world's proven reserves.¹⁶³ With the help of massive foreign investments, Kazakhstan was able to increase its production to 811,000 bbl/d in 2001, after its massive decline following the demise of the Soviet Union. The production rates for 2010 and 2015 are expected to be 2 million bbl/d by 2010 and 2.5 million bbl/d by 2015. In 2001, Kazakhstan exported 631,000 bbl/d solely through Russian pipelines, as it is the sole means of a connection for Kazakhstan to the world market. Several pipeline projects with Russia and via the Caucasus to Turkey will enable Kazakhstan to increase its exports further so that it will grow to as a significant player on the oil market.¹⁶⁴ Kazakhstan's proven gas reserves are remarkable too. Approximately 65 Tcf are expected to exist on its territory.¹⁶⁵ However, because of a limited gas infrastructure, Kazakhstan is indeed a gas importer. In order to become independent of Uzbekistan's gas imports and to benefit from its reserves, the Kazakh government intends to increase its gas production to 1.84 Tcf in 2015. This would enable Kazakhstan to export 1.2 Tcf in the same year, as the domestic consumption is expected to remain stable.¹⁶⁶

The outlook on Turkmenistan's oil sector is somewhat vague, in that the reserve predictions vary. While BP predicts only 0.5 billion barrels for Turkmenistan,¹⁶⁷

¹⁶² DoE/EIA, *Azerbaijan Country Analysis Brief*.

¹⁶³ BMWI, *Energiedaten 2002*, 47.

¹⁶⁴ DoE/EIA, *Kazakhstan Country Analysis Brief* (July 2002), <http://www.eia.doe.gov/emeu/cabs/kazak.pdf> (09 June 2003).

¹⁶⁵ BMWI, *Energiedaten 2002*, 48.

¹⁶⁶ DoE/EIA, *Kazakhstan Country Analysis Brief*.

¹⁶⁷ BP, 4.

the US EIA expects possible reserves of up to 1.7 billion barrels.¹⁶⁸ Although that Turkmenistan is already a net oil exporter, approximately 3.9 million barrels in 2001, it will take several years until Turkmenistan will be able to come up to its possible potential. The reason being the unfavorable investment climate in the energy sector, which is heavily regulated by the government and hinders foreign oil producers to access export pipelines. Additionally, the energy prices are set by the state and are well below international market price. The same constraints exist for the gas sector with the additional disadvantage that Turkmenistan has its only access to the global market through Russia (via Kazakhstan) and, to a lesser extent, Iran. However, with 101 Tcf proven gas reserves, Turkmenistan owns the ninth-largest world reserves.¹⁶⁹ Since 1998, Turkmenistan was able to increase its gas production in large steps, from 0.47 Tcf to 1.64 Tcf in 2000. The export exploded likewise, as the domestic consumption grew only slightly from 0.16 Tcf to 0.26 Tcf during the same timeframe. Hence, Turkmenistan exported already 1.38 Tcf in 2000 and a further increase in production and export can be expected, despite the constraints mentioned earlier.¹⁷⁰

Although Uzbekistan is still a small oil exporter, approximately 30,000 bbl/d in 2000, this will change soon, as the production will decline to 120,000 bbl/d until 2005.¹⁷¹ The reasons are the depleting reserves, which will only be available until the beginning of the next decade.¹⁷² The situation of the gas sector is slightly better. The predicted proven gas reserves are of 66.2 Tcf.¹⁷³ The EIA expected a production rate of 2.03 Tcf in 2001, while consuming slightly more than 1.51 Tcf as in 2000. As Uzbekistan exported 0.48 Tcf in 2000, the export in 2001 is expected to increase also.¹⁷⁴

¹⁶⁸ DoE/EIA, *Turkmenistan Country Analysis Brief* (May 2002), <http://www.eia.doe.gov/emeu/cabs/turkmen.html> (09 June 2003).

¹⁶⁹ BP, 20.

¹⁷⁰ DoE/EIA, *Turkmenistan Country Analysis Brief*.

¹⁷¹ DoE/EIA, *Uzbekistan Country Analysis Brief* (May 2002), <http://www.eia.doe.gov/emeu/cabs/uzbek.html> (09 June 2003).

¹⁷² BP, 4.

¹⁷³ Ibid., 20.

¹⁷⁴ DoE/EIA, *Uzbekistan Country Analysis Brief*.

The statistical range by this production rate would be 32.6 years (2001), however, the question is how the Uzbek energy market is developing while the oil production is declining. If the domestic demand will be served increasingly by gas, not only the small export quote will rapidly decline, but also the statistical range of the domestic gas reserves.

f. Middle East

This section includes the countries in the Persian Gulf and Arabian Peninsula, as well as Syria and Yemen. Countries of the Middle East are generally blessed with tremendous reserves, mostly ranging for several decades often for more than one hundred years.

The total proven oil reserves of the Middle East are predicted with more than 685 billion barrels. These are over 65% of all global oil reserves and provide for a statistical range of at least 86 years. By far the largest oil reserves, 261.8 billion barrels, are owned by Saudi Arabia, which owns 36% of world reserves. The next largest group is built of Iran, Iraq, Kuwait and United Arab Emirates (UAE), making up reserves for 8.5% (98.7 billion barrels) to 10.7% (112.5 billion barrels) of the total global reserves. All together, these five states provide 62.6% of all proven reserves.¹⁷⁵

The amount of proven gas reserves is not as large as the oil reserves. However, with more than two-third (36.1%) of the global proven reserves, this region is as important as the FSU (36.2%) countries. Nevertheless, the overall statistical range is far beyond 100 years. Iran has, by far, the largest gas reserves (812.3 Tcf, 14.8% of world reserves) for this region and the second-largest worldwide.¹⁷⁶

¹⁷⁵ BP, 4.

¹⁷⁶ BP, 20.

3. SUMMARY

The global energy consumption will grow by nearly 60% by 2025, while the significance of fossil fuels will increase as well. Despite the efforts to improve energy efficiency and renewable energy production, the share of fossil fuels will increase from 81% to 88% by 2025. The importance of oil and gas will, therefore, increase further. On the other hand, oil and gas reserves will become depleted in several countries already within the next decade.

The huge US demand will absorb the supply from among the American continent, as most probably, Canadian and Mexican imports will have to be substituted within one decade, provided they will not be able to recover additional reserves and / or turn resources into reserves. The importance of the entire American continent, in terms of energy supply, will therefore be only regional.

The African continent is also limited to a regional provider either. Northern African gas supply will be absorbed by Europe, while Nigerian oil and gas will be provided world wide, although with limited shares.

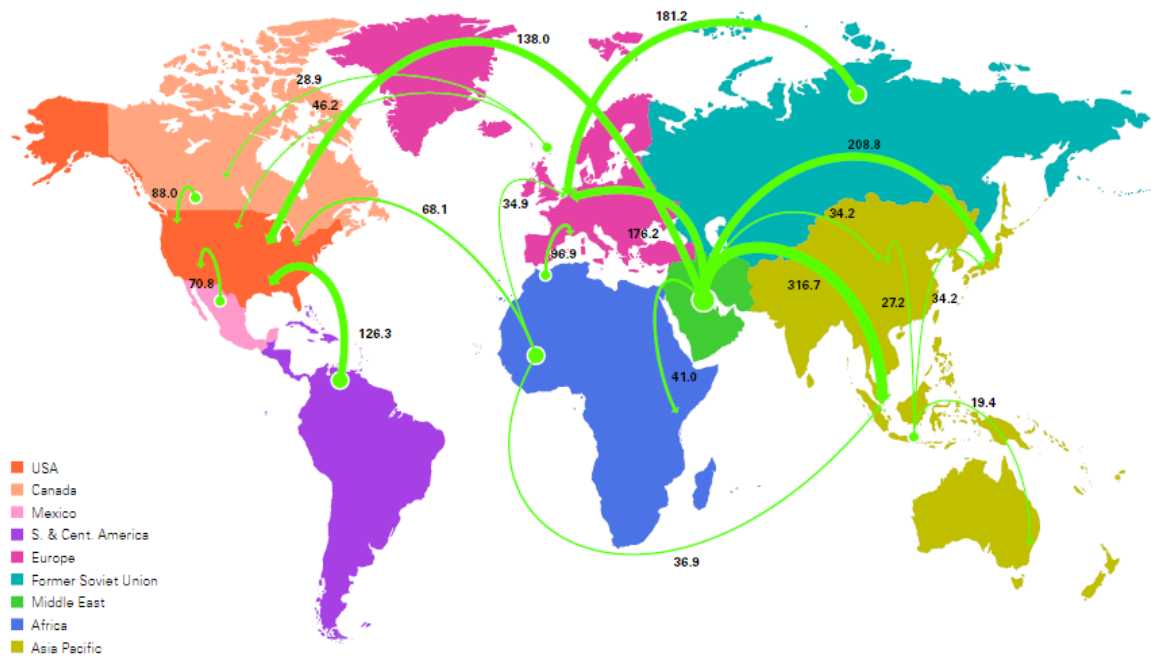
After 2010, the Asia Pacific region will have remarkable gas reserves left to distribute. However, like today the ever-growing Chinese demand will absorb these supplies as will Japan and Korea. Hence, also the Asia Pacific will be of only regional importance.

The only regions left that will be capable of providing oil and gas on a global level to meet the growing world demand will be the Middle East, Russia and other Caspian Sea neighbors. In terms of oil it will be the Middle East and Caspian Sea (see Figure 4.7), and in terms of gas it will be predominantly Russia, along with the Middle East (see Figure 4.9).

These developments are already reflected by the current trade routes (Figures 4.11 and 4.12) and these conditions will intensify further over the coming decades.

Figure 4.11: Major Current Oil Trade Movements

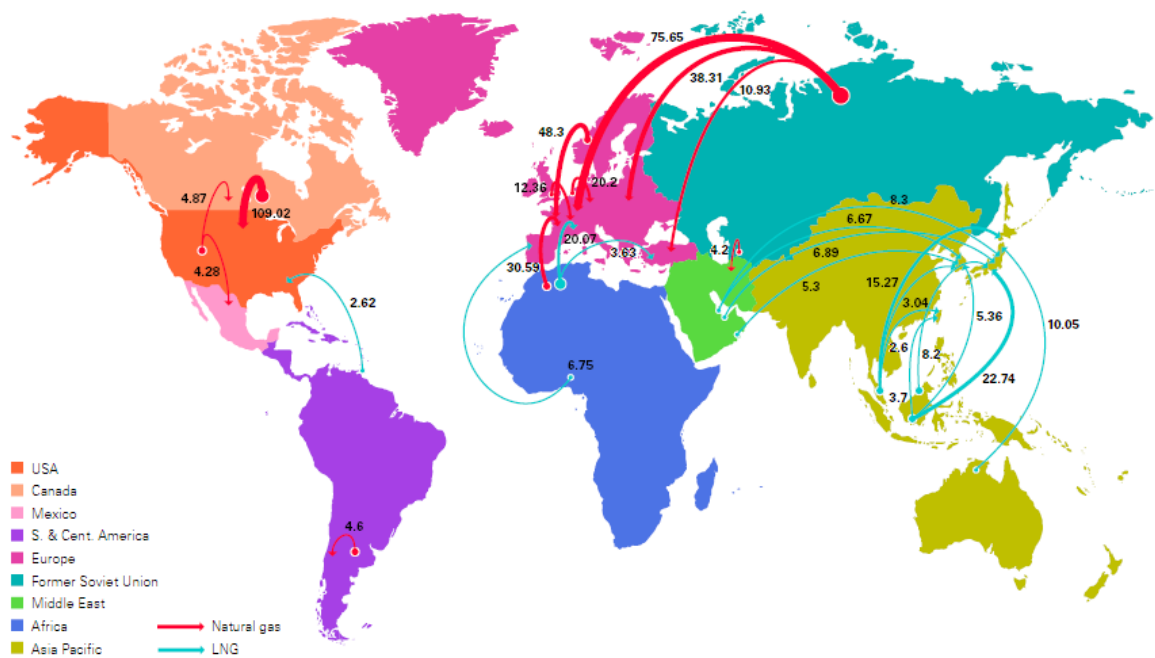
Trade flows worldwide (million tonnes)



(From: BP, 19)

Figure 4.12: Major Current Gas Trade Movements

Trade flows worldwide (billion cubic metres)



(From: BP, 29)

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V. CONCLUSION

In the previous chapters, it was argued that the energy supply on the international energy market will significantly shift within one decade. In summary, one fact is clear: Germany's energy import dependence will undoubtedly increase in the future. Even in the most optimistic case, energy consumption will decrease thorough 2020 by 3%, nuclear energy will have to be substituted by fossil fuels, upon which import Germany is already highly dependent. The import dependence in the mid-term can be expected to increase to at least three-fourth of the future total primary energy consumption. On the other hand, the oil and gas supply situation for Germany will become more complex in the next decade. Since oil imports from the UK and Syria are expected to cease after 2005, 18% of the current oil supply will have to be substituted within this decade. Russia, however, may not be available to provide the amount necessary, as its current investments are already far below the requirements needed to meet the goals of the Russian energy strategy. The gas situation is somewhat less urgent, as a supply shift will have to take place only after 2010, when the Norwegian and Dutch gas reserves cease to satisfy the export demand. The only regions left that will be able to provide oil and gas on a global level to meet the growing world demand will be the Middle East, Russia and other Caspian Sea neighbors. In terms of oil, it will be the Middle East and Caspian Sea, and in terms of gas, it will be the Middle East and Russia.

The huge US demand will absorb the supply from the American continents, as most likely, Canadian and Mexican supply will have to be substituted within one decade, provided they will not be able to recover additional reserves and / or turn resources into reserves. The significance of the entire American continent in terms of energy supply will, therefore, be only regional. The African continent will also be limited to a regional provider. Northern African gas supply will be absorbed by Europe, while Nigerian oil and gas will be provided worldwide, although with limited shares. After 2010, the Asian Pacific region will be only possessing remarkable gas reserves left to distribute. However, like today, the ever-growing Chinese demand, plus Japan and South Korea will absorb these supplies. Hence, the Asian Pacific will also be of only regional importance.

The consequences for the German foreign energy policy are manifold. As there is nearly no possibility to avoid the future concentration of oil and gas supplier, Germany, in cooperation with the EU, at a minimum will have to diversify the supply routes and distribution companies as far as possible. The outlet for the Caspian Sea and Central Asian fuels is still primarily available via means of Russia. The INOGATE programs of the EU, financing and supporting pipeline projects in Azerbaijan and Georgia connecting the Caspian Sea / Central Asia region with Europe, are steps in the right direction and should be continued. Similar projects should be sought as well to connect the underdeveloped energy sectors of North African states with Europe.

Most of the national energy sectors are still state owned or directed. The German government will have, therefore, to support the private German oil and gas companies to acquire future desired contracts. These will not only support contracts in terms of long-running delivery agreements, but also those of the internationally standard small German oil and gas producing companies, such as Wintershall (active in Russia and Algeria) and GWDF (Georgia and Kazakhstan).

Although the OPEC monopoly will become even more important in the future, provided it survives the current struggles, Germany and the EU should try to limit the possible price gauging effects with politically and economically attractive contracts / agreements on bi-national levels. These could be in terms of favorable accession to special EU markets and particular support / development measures. One issue, which should, however, be high on the German government's agenda, is to prevent the creation of a gas monopoly similar to OPEC with political means. With the founding of the Gas Exporting Countries' Forum (GECF), Algeria and Russia have especially tried to build such kind of an organization.

Germany's welfare is directly dependent on its economical success. As a highly industrialized country, Germany should take a tremendous interest not only in the future development of the international energy market, but also in attempting to influence the development immediately following that of its domestic needs. A common EU energy strategy, as is currently under discussion with the EU "Green Paper", proposes a significant and promising way. However, in order to influence this discussion, Germany should create a national foreign energy strategy, in opposition to that of a purely domestic energy policy. Moreover, until the EU achieves a common strategy, a national foreign energy strategy will be essential to ensure further economic development and welfare in Germany, particularly in order to fill areas the EU might not cover.

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